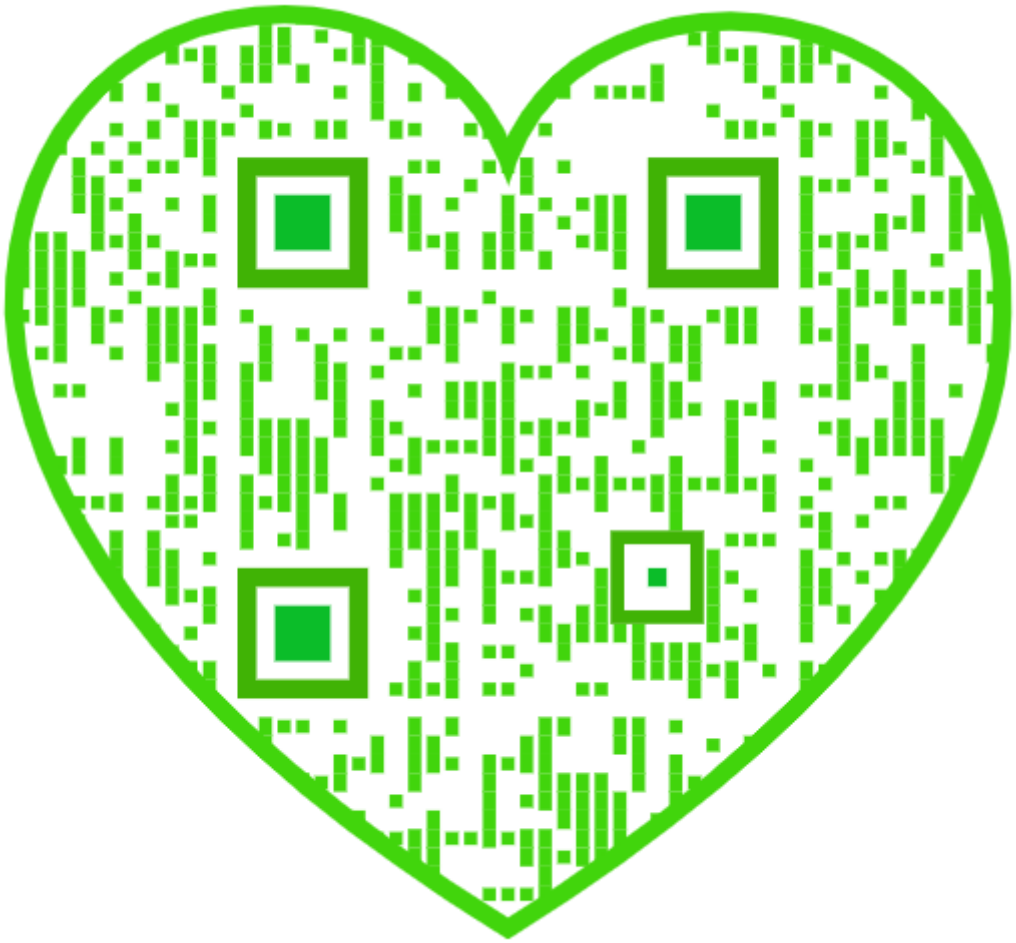

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DEPARTMENT OF THE INTERIOR
BUREAU OF AGRICULTURE

FARMERS' BULLETIN No. 12
(REVISED EDITION)

ABACÁ (MANILA HEMP)

BY

H. T. EDWARDS
Assistant to the Director of Agriculture

AND

MURAD M. SALEEBY
Fiber Expert

MANILA
BUREAU OF PRINTING
1910

92951

PLATE 1. ABACÁ, MAGUINDANAO AND TANGOÑGON VARIETIES.

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LETTER OF TRANSMITTAL.

MANILA, *January 8, 1910.*

SIR: We have the honor to transmit herewith, and to recommend for publication, a revision of Farmers' Bulletin No. 12, "Abacá" (Manila hemp).

Very respectfully,

H. T. EDWARDS,
Assistant to the Director.
MURAD M. SALEEBY,
Fiber Expert.

DIRECTOR OF AGRICULTURE,
Manila, P. I.

ABACÁ (MANILA HEMP).

INTRODUCTION.

The fiber produced by the plant *Musa textilis* is known throughout the civilized world as hemp, manila, or manila hemp. This name "hemp" is misleading as, properly speaking, hemp is the fiber produced by the plant *Cannabis sativa.* The two fibers are quite different, manila hemp being a structural fiber obtained from the leaf sheath while true hemp is a bast fiber extracted from the inner bark of the stem. The name "abacá" is used in all parts of the Philippine Archipelago to designate both the plant, *Musa textilis,* and the fiber, manila hemp.

Abacá enjoys the unique distinction of being strictly a Philippine product. The plant has been introduced into India, Borneo, the West Indies, and other parts of the tropical world, but only in the Philippine Islands has the fiber been successfully produced as an article of commerce. This fact has undoubtedly been of great advantage to the Philippine planter. The lack of competition, however, has resulted in the continuance of obsolete methods of cultivation and fiber extraction, better suited to the eighteenth than to the twentieth century.

The opportunities for increasing the production of abacá in the Philippines are almost unlimited. Enormous areas of land suitable for abacá cultivation are as yet untouched, while the greater part of the land already under cultivation might yield a greatly increased product if more careful attention were given to the various details of cultivation. The introduction of irrigation and drainage will greatly increase the output of abacá in the localities where it is under cultivation and will also make possible the planting of abacá in many districts where it is now unknown. The perfection of a machine for the extraction of the fiber will considerably increase the entire output by saving a part of the fiber that is now wasted by the hand-stripping process.

In each successive step, from the first selection of the land to the final treatment of the fiber, the progressive planter should have as his ultimate object the production on a given area of a maximum quantity of superior fiber at a minimum cost. With the industry established and conducted on this basis, abacá will continue to hold its place as the most important export product of the Islands.

HISTORY.

The first authentic account of the use of either abacá or banana fiber in the Philippines is that given by an Englishman, Dampier, who lived in Mindanao in 1686. This writer describes the "banana textoria," both as an edible and as a fiber-producing plant. One of the companions of Magallanes, Antonio Pigafetta, prepared a description of the plants of the Philippines, but in this paper no mention is made of abacá. The fiber was first exported from the Islands about the beginning of the last century, but the exports did not become important until about 1850. In 1820 a sample of abacá was brought to Salem, Massachusetts, by John White, a lieutenant in the United States Navy. From 1824 to 1827 the fiber began to be used quite extensively in Salem and Boston. The gradual increase in production is shown by the following table:

Exports of abacá from the Philippine Islands.

	Tons.
1818	41
1825	276
1840	8,502
1850	8,561
1860	30,388
1870	31,426
1880	50,482
1890	67,864
1900	89,438
1906	112,165
July 1, 1908, to June 30, 1909	149,992

The numerous attempts which have been made to introduce abacá into other countries have never met with any considerable degree of success. In 1822 experimental plantings were made in Calcutta and in 1877 in Madras. The plants grew fairly well in both instances, but the fiber produced was of an inferior quality. The experiments with abacá in the Andaman Islands, Borneo, Florida, and the West Indies have not resulted in any general introduction of the plant into these countries.

BOTANY.

The common banana, *Musa sapientum;* the plantain, *Musa paradisiaca;* and abacá, *Musa textilis,* are closely related species of the same genus. The plants of these three species resemble each other both in appearance and in habits of growth. The banana plant produces a fiber similar in appearance to abacá, but lacking strength. The fruit of the abacá somewhat resembles that of the banana, but is smaller, filled with black seeds, and of no economic value.

The abacá plant is a large tree-like herb 5 to 10 meters high. The stalk rises from a perennial rootstock. A single rootstock usually bears a cluster of from 12 to 30 stalks or shoots. The stalk is cylindrical, 2.5 to 6 meters long, ranging in color from dark purple to green, and is

formed of the overlapping leaf sheaths. The leaves are oblong, deltoid at the base, bright green above, glaucous beneath, petiole from 0.3 to 1 meter long. The sheaths grow from the fleshy, central core until the sheath formation is completed, when the flower bud develops and forms the flowering spike which varies in size and length with different varieties. The flowers are borne in clusters arranged at intervals along the rachis, each cluster being subtended by a large membranous bract. The first few bracts which subtend the real flowers are larger and more conspicuous than the rest that subtend the false flowers. The latter bracts are so densely laid one upon the other that they form a kind of flower cone. This cone is smooth, glossy, and of a color ranging from dull violet to light green. The fruit is green, oblong-trigonous, 5 to 8 centimeters long, 2.5 centimeters in diameter, not edible, but filled with large, black seeds.

While the abacá plant closely resembles the banana, the two may easily be distinguished. The abacá is ordinarily smaller than the banana, its stem is more slender and usually of a darker color. The abacá leaf is a darker green, narrower, more tapering, and of a firmer texture than that of the banana. The petiole of the abacá leaf is of a light green color while that of the banana is ashy. A peculiarity of the abacá is a dark, thread-like line running lengthwise on the right-hand side of the under surface of the leaf.

There are many different varieties of abacá, often six or eight in one locality. The principal differences between these varieties are in color and shape of stalk, color and size of leaves, greater or less tendency to produce suckers, and in development, quality, abundance and strength of fiber. The desirable qualities in an abacá plant are: A plant which is hardy, grows rapidly, and withstands draught, and which produces fiber in abundant quantity, of good quality, and easily extracted.

VARIETIES OF ABACÁ.

As many as fourteen, or more, varieties of abacá are under cultivation in the leading abacá provinces. The principal differences among these varieties are in color, size, and shape of the stalk; tendency to produce suckers; and in yield and quality of fiber. The color and shape of the flower cone can not ordinarily be depended upon as distinguishing characteristics, excepting in the Lubuton and Punucan varieties where a marked difference in color can easily be detected. The way the leaves hang on the stalk, as well as their size and shape, will be referred to occasionally.

There is also a great difference in the degree of hardiness in the different varieties of abacá. Some varieties may thrive fairly well under conditions where others less hardy will fail altogether. The abacá planter should be able to identify the leading varieties, and should be

sufficiently familiar with their characteristics so that he may determine which varieties are best suited to conditions in any given locality. This question is one of great importance, especially to the prospective planter.

This subject is obviously full of difficulties inasmuch as some varieties shade one into another, rendering it extremely difficult to describe the minute differences existing among them; besides, variations in soil and climatic conditions cause changes in certain characteristics of the same variety. A comprehensive study of the varieties of abacá throughout the Philippine Islands is yet to be made. It is believed, however, that the following data on this subject will be of assistance to the abacá planter.

In different localities the same varieties are known by different names. The following names of varieties are used in southern Mindanao where our principal studies and experiments have been made: (1) Tangoñgon, (2) Maguindanao, (3) Bangulanon, (4) Libuton, (5) Punucan, (6) Arúpan, (7) Puteean, (8) Sinaba, (9) Agutay, (10) Baguisanon Lawaan, (11) Baguisanon, (12) Pulajan, (13) Puspos, and (14) Kawayanon. The first eight are the principal varieties, and the last six are the undesirable ones that should be avoided for reasons hereafter given.

TANGOÑGON.

(*Tangoñgon*, throughout Davao, Iligan, and other parts of Mindanao; *Lagurjuan*, Leyte; *Samorong itom*, Albay and Ambos Camarines.)

Color of stalk.—The color of the Tangoñgon stalk is both light and deep purple, with hardly any green lines running through as in most other varieties. Often the color on the outward side of the stalk is deeper, almost approaching black, due to its exposure to the sun. The dark and glossy aspect of the Tangoñgon hill is peculiar, and few other varieties can be mistaken for it.

Size of stalk.—The stalks may grow to a great height and size, especially in what the natives call the "male Tangoñgon" or "Tangoñgon Lawaan." Stalks measuring 6 meters in height, weighing 90 to 115 kilos, and containing from 2 to 2.5 kilos of dry fiber are occasionally found.

Shape of stalk.—The stalk tapers as in most other varieties; the ratio between the circumference at the base and at the top being 2.1 to 1.

Tendency to produce suckers.—The male variety, that has been mentioned before as bearing large stalks, does not produce as many suckers as the female variety, which has smaller stalks. In other respects the two behave exactly the same. On an average the number of stalks in the Tangoñgon hill can be estimated at 10 to 12.

Quality of fiber.—The fiber is coarser and stronger than that of the other varieties, but not so white. Its coarseness and brownness are partly

PLATE 2. ABACÁ, LIBUTON VARIETY.

PLATE 3. ABACÁ, SINABA AND TANGOÑGON VARIETIES.

PLATE 4. FIELD CLEARED FOR PLANTING.

due to imperfect stripping. To strip this variety for any considerable length of time is a trying task and one that is avoided by most strippers.

Quantity of fiber.—Every 100 kilos of stalk contain from 2.5 to 2.75 kilos of dry fiber.

The Tangoñgon is undoubtedly the hardiest variety, and grows to a fair size even in poor soils and under other adverse conditions, where most, if not all, of the other varieties can not survive. The difficulty of stripping it, its hard and woody rootstock, as well as the size of its stalk and leaves, all show its hardy nature.

It reaches its limit of growth in alluvial flats subject to overflow by mountain streams. One of the undesirable qualities of this variety is the tendency on the part of the rootstocks to grow above the soil. As a result, quite a number of suckers grow 6 to 8 centimeters above the ground, the hold of the plant on the soil is weakened, and it is in danger of being thrown over during strong winds.

MAGUINDANAO.

(*Maguindanao*, throughout Davao; *Ynosa*, in Leyte; *Samarong puti*, in Albay and Camarines; *Laob*, in Oriental Negros; and *Samponanon*, in northern Mindanao and Camigin.)

Color of stalk.—Greenish, with light purple and brown colors running through it. As a rule, the green color is in excess of the purple and brown, but during long dry spells the reverse is the case.

Size of stalk.—In its favorite soil—light deep loams—it grows to almost the size of Tangoñgon, but it does not, as a rule, grow quite so high. Stalks weighing 100 kilos and measuring about 5.5 meters in height are about the limit, though in a few exceptional cases stalks weighing 123 kilos have been observed.

Shape of stalk.—Even a little more tapering than Tangoñgon, the ratio between the two circumferences being about 2.3 to 1.

Tendency to produce suckers.—It produces more stalks to the hill than Tangoñgon, from 15 to 20 stalks being about the average.

Quality of fiber.—White, strong, and easy of extraction.

Quantity of fiber.—Every 100 kilos of stalk contain about 1.75 kilos of dry fiber.

This is a favorite variety with the majority of planters throughout the Islands, because of the superior quality of its fiber and the ease with which it is extracted. It is reckoned among the hardy varieties, though it falls short of Tangoñgon in this respect. The way the leaves hang on the stalk is peculiar to this variety. As soon as they emerge from the stalk, the leaves arch downward in the form of a bow, giving the plant the shape of an umbrella.

BANGULANON.

(*Bangulanon*, throughout Davao, Cebu, and Oriental Negros; *Alman* (?), in Leyte.)

Color of stalk.—Dark and dull, with very little, or none, of green and light colors.

Size of stalk.—In height, as well as in weight, this variety rarely grows stalks of more than medium size. A stalk of 50 to 60 kilos in weight and 3.5 to 4.5 meters in height is considered of good size.

Shape of stalk.—One of the least tapering of the varieties, the difference between the two circumferences being about 1.8 to 1. This characteristic is not noticeable, owing to the small size of the stalks.

Tendency to produce suckers.—It ranks second in the number of stalks in its hills, 25 to 30 stalks being frequently seen in one hill.

Quality of fiber.—Very white, strong, heavy, and easy of extraction. In this respect it ranks equal, if not superior, to Maguindanao fiber.

Quantity of fiber.—Every 100 kilos contain from 2.25 to 2.30 kilos of dry fiber.

This variety is rarely found outside of southern and eastern Mindanao. Its first home was probably the eastern coast of Mindanao, from which it was introduced to both coasts of the Gulf of Davao.

The "Alman," which is extensively cultivated in Leyte, is very similar to Bangulanon and is perhaps the same. The "Alman" differs from the Bangulanon only in its lighter color, and in having fewer stalks to the hill, which may be accounted for by different soil and climatic conditions. A few Bangulanon hills are also found in the mountains back of Luzuriaga, Negros Oriental, and also in Cebu back of the towns of Dalaguete and Oslob.

This variety, like Tangoñgon, thrives best in the soft alluvial loams, underlaid by gravel, but it is not considered a hardy variety. In heavier soils, a few stalks in each hill fall over before maturing. This is the case especially in ill-drained soils.

One pecularity of the Bangulanon is the spreading out of its stalks, perhaps due to overcrowding. Of late it has gained a great reputation among the planters of southern Mindanao on account of the abundance and superior quality of its fiber, and the ease with which it is extracted.

LIBUTON.

(*Libuton*, throughout southern and northern Mindanao; *Tangoñgon*, in Iligan; and *Libutanay*, a corruption of Libuton, in Leyte.)

Color of stalk.—A combination of deep green and brown. The light purple colors of the Maguindanao being absent.

Size of stalk.—Though the stalks do not grow to the size of the Tangoñgon, yet this variety is considered as giving good-sized stalks. In

this respect, as well as in height, it compares very favorably with Maguindanao.

Shape of stalks.—Less tapering than either Tangoñgon or Maguindanao, the ratio being about 2 to 1 or a little less.

Tendency to produce suckers.—Libuton produces more stalks to the hill than any of the varieties above described, with the exception of Bangulanon, 20 to 25 stalks being a fair average.

Quality of fiber.—Not quite so white nor easy to strip as that of Maguindanao or Bangulanon. It is much whiter than the Tangoñgon and also easier to strip.

Quantity of fiber.—Slightly less than in Maguindanao. Every 100 kilos of stalk contain from 1.65 to 1.70 kilos of dry fiber.

The Libuton is almost, though not quite, as hardy as Tangoñgon; but it surpasses it, and all the rest of the varieties, in having a much stronger hold on the soil. Libuton stalks unless overmature or subjected to unusually strong winds are seldom blown down. The color of its flower cone, as well as that of Punucan, is lighter and greener than in other varieties.

PUNUCAN.

This variety is exactly like Libuton in all characteristics, with the exception of color and the number of stalks in the hill. In color, tendency to produce suckers, and general outward appearance it greatly resembles Tangoñgon; while in quality and quantity of fiber it is exactly identical with Libuton. It is often mistaken for Libuton or Tangoñgon. No further description is necessary, as it will be merely a repetition of what has been mentioned under the Tangoñgon and Libuton varieties.

ARUPAN.

(*Arupan*, throughout southern Cebu and parts of Davao; *Tilitian* and *Babaounon*, in Davao; *Sina-Moro*, in Leyte; *Samponanon*, in northern Mindanao and Camigin; *Laob*, in Oriental Negros; *Samorong puti*, in Albay and Camarines; and *Puteean Grande*, in Iligan.)

Color of stalk.—More greenish than Maguindanao and Puteean. It is also noticeable that the green color in it is somewhat lighter than that in the other two varieties.

Size of stalk.—It does not grow to a considerable height, but in thickness it compares well with either Maguindanao or Libuton.

Shape of stalk.—The least tapering of all varieties, 1.75 to 1 being the approximate ratio between the two circumferences.

Tendency to produce suckers.—About equal to Maguindanao.

Quality of fiber.—Owing perhaps to the presence of a stronger solution of tannic acid in it, the fiber is generally dull in color. The quality can be considerably improved if the strips are pulled under the knife as soon as, or shortly after, they are separated.

Quantity of fiber.—Every 100 kilos of stalk contain about 1.75 kilos of dry fiber.

In general appearance this variety is very similar to Maguindanao and most of the following varieties; hence very few planters give it a separate name. It is extensively grown, and can be seen in almost any district where abacá is extensively cultivated.

There are three characteristics peculiar to this variety. These are, the comparative shortness of the stalk, the comparative thickness at the top, and the change in the color of the strips shortly after they are separated. This latter characteristic, as previously mentioned, is probably due to an excess of tannic acid in its sap. On account of this last peculiarity, the Moros of the Tagum River Valley in the District of Davao call it "Tilitian," meaning a stain.

PUTEEAN.

(*Puteean*, throughout Davao, Cebu, and Mindanao; also *Puspos*, in Davao; *Laguis*, in Leyte; and *Laob*, in Oriental Negros.)

Color of stalk.—Very similar to that of Maguindanao, with the possible difference of being slightly darker and less lustrous.

Size of stalk.—Both in thickness and height of stalk it resembles Bangulanon.

Shape of stalk.—The thickness of the stalk at the base is about double that at the top.

Tendency to produce suckers.—Somewhat less than in either the Arupan or the Maguindanao, or about the same as Tangoñgon.

Quality of fiber.—Very white, as the word implies. Strippers claim that it is more difficult to extract Puteean than either Maguindanao or the Bangulanon fiber, but if any difference in this respect exists it is very slight.

Quantity of fiber.—About the same as Arupan and Maguindanao.

A bad reputation (to some extent, unjustly) has been attached to this variety. Although it is neither hardy nor produces many and large stalks to the hill, yet its fiber, both in quality and quantity, approaches that of Maguindanao. It receives its bad reputation for the reason that almost any small unhealthy hill of hemp, whether it is Puteean or something else, is called "Puteean." Thus it has been condemned more through mistaking it for some of the inferior varieties, such as Baguisanon, Puspos, etc., than because of any undersirable qualities that it actually has.

The real Puteean, when grown in its favorite soil—soft sedimentary loam—is often mistaken for Maguindanao, as the color of its stalks is then very similar to that of the Maguindanao; but, to the experienced eye, the tapering of the Maguindanao stalks and the arching of its leaves afford a plain contrast to the less tapering Puteean stalk and the straight growth of its leaves.

SINABA.

(*Sinaba*, in certain localities in Davao; *Maguindanao*, throughout the greater part of Davao; *Liajon*, in Leyte; and *Puteean*, in northern Mindanao, Cebu, and Negros Oriental.)

Color of stalk.—The greater part of the stalk is usually green. Toward the base purplish patches or lines are frequently seen.

Size of stalk.—In thickness the stalks compare favorably with Arupan, but in height they even fall short of Puteean or Arupan.

Shape of stalk.—Very similar to Arupan, if not exactly identical with it.

Tendency to produce suckers.—The stalks in this variety are numerous and crowded. In this respect it even surpasses Libuton, though it does not come up to the average of Bangulanon.

Quality of fiber.—The whitest, finest, and lightest fiber is produced by this variety.

Quantity of fiber.—This fiber is both light and weak, and during the two processess of extracting it, considerable percentage of it goes into waste. Every 100 kilos of stalk contain about 1.25 kilos of dry fiber.

This variety should have been given the name of "Puteean" because it possesses all of the qualities conveyed by the meaning of the word. "Sinaba" is a very local name, and is given to this variety because of the close resemblance it has to the "Saba" variety of banana, the fine and silky fiber of which is woven into what is called "Saba cloth" in almost all parts of the Islands.

This is another variety the identity of which has not been generally known.

AGUTAY.

(*Agutay*, in Davao; *Alman*(?), in Leyte; and, perhaps, *Samorong itom*, in Albay and Camarines.)

Color of stalk.—Very similar to that of Tangoñgon, only it does not have the luster of the latter.

Size of stalk.—The stalk never grows to any considerable size or height. It rarely comes up to the Puteean standard.

Shape of stalk.—About the same as the Libuton stalk.

Tendency to produce suckers.—The Agutay hill produces very few suckers. It and Tangoñgon have the least number of stalks in their hills.

Quality of fiber.—Very white, almost as white as that of Sinaba, with the difference that it lacks the softness and luster that the latter has.

Quantity of fiber.—Owing to occasional breaking of the strips during the process of separating them, a great loss in quantity results. Every 100 kilos of stalk contain from 1.3 to 1.4 kilos of dry fiber.

Agutay has a bad reputation which it deserves. To what has been mentioned may be added another undesirable quality, and that is its weakness of growth. It is one of the least hardy varieties of abacá.

BAGUISANON LAWAAN.

(*Baguisanon Lawaan* or simply *Baguisanon*, in some parts of Davao; *Lackbanon*, along the north and east coasts of the Gulf of Davao; *Ijalas*, in Leyte; *Tinabonó*, in Oriental Negros; *Baguisanon*, in Cebu; and *Baounon*, in northern Mindanao.)

Color of stalk.—When mature, light green color pervades the whole stalk, even to the very base.

Size of stalk.—The limit of the growth of abacá in size, as well as height, is attained in this variety only. One of the stalks, cut for experiments made in the Davao River Valley, measured 1.16 meters in circumference at the base, about 7 meters in height, and 166 kilos in weight.

Shape of stalk.—Thickness at the base about double that at the top.

Tendency to produce suckers.—It produces as many stalks to the hill as Bangulanon and often more. The stalks are packed close together, making it very difficult to cut out the mature stalks from the rest.

Quality of fiber.—White, fine, and weak.

Quantity of fiber.—With the present wasteful method of extracting fiber not more than 1.3 or 1.4 kilos is contained in every 100 kilos of stalk. The reason is that during the process of separating the strips from the sheaths, the strips often end a little beyond the middle of the sheath. The men can never manage to pull the strip to the end, due both to the weakness of the fiber and the comparative compactness of the tissue cells. On this account all strippers avoid this variety. If the mature stalks, after being cut, were left from five to ten days on the ground, the strips could then be entirely separated, owing to the deterioration of the tissue binding the fiber together. The only disadvantage in the above method is that the strips lose their white color, and the fiber becomes dull.

BAGUISANON.

(*Baguisanon*, in Davao and Cebu; *Macalibre*, in Iligan; *Lawisid* in Camigin; *Lawitz*, in northern Mindanao; *Banguisan*, in Leyte; and *Salawag*, in Oriental Negros.)

In general appearance, and in number and size of stalks, it resembles the Sinaba to such an extent as to render a description of it a mere repetition of what has been mentioned under the latter.

In breaking of the strips during the process of separating them from the sheath, as well as in the weakness of its fiber, it ranks even inferior to Baguisanon Lawaan. Its fiber is, however, somewhat whiter and lighter. Very rarely more than 1 kilo is contained in every 100 kilos of stalk.

PULAJAN.

(*Pulajan* and *Baguisanon itom*, in Davao; *Linawaan*, in Leyte; and *Caguisan*, in Oriental Negros.)

The color of this variety, as the word implies, is red, even more so than Tangoñgon. In shape of the stalks and their height and size it resembles Tangoñgon, differing from it in having a stronger tendency to produce suckers. In the rest of its qualities it behaves exactly the same as Baguisanon. This fact explains why many of the planters in southern Mindanao call it "Baguisanon itom."

PUSPOS AND KAWAYANON.

These two can be described jointly for the reason that they resemble each other, and both of them are so distinctly different from the rest of the varieties that there can be no danger of mistaking them. They both bear small and numerous stalks to the hill. The stalks rarely grow more than 2.5 to 3 meters high, and the fiber, though white, is weak and the yield is small. The Kawayanon stalks are usually more purplish and shorter than those of the Puspos. In various parts of the Islands these varieties are given the names of either Puteean, Lawisid, or Lawits, while in Leyte a variety "Itimbalod" answers to the description of both Puspos and Kawayanon.

DISTRIBUTION.

Abacá is distributed throughout the greater part of the Philippine Archipelago. The area where it is successfully cultivated lies, approximately, between the parallels 6 and 15 north latitude and meridians 121 and 126 east of Greenwich. The most favorable locations are along the eastern and southern coasts. It may be cultivated up to 1,000 or 1,200 meters above sea level, but above this height the temperature is not favorable to its best development. The more important abacá provinces and islands are as follows: Albay, Leyte, Sorsogon, Mindanao, Samar, Ambos Camarines, Negros, and Mindoro. It is grown to some extent in other provinces of Luzon and on many of the smaller islands. The amount of land at present under cultivation, or that which is suitable for abacá, can not be very definitely estimated, inasmuch as the plant is often grown on small and widely scattered areas back in the mountains. The methods of propagation, of cultivation, and of fiber extraction are all very similar in the different parts of the Archipelago.

CLIMATE.

A suitable climate is the first and most important requisite for successful abacá cultivation. In selecting the location for a plantation this subject should receive the most careful attention. The four conditions of climate which directly affect the growth of abacá are the amount and distribution of rainfall, the degree of atmospheric humidity, the frequency of heavy winds, and the degree of temperature.

The structure and habits of growth of the abacá plant are such that it requires a large and continuous supply of moisture. We invariably find that the provinces where abacá cultivation is the most successful are those having a heavy and evenly distributed rainfall. In many parts of the Philippine Islands there is a long and pronounced dry season, during which time there is practically no rainfall. Unless water is available for irrigation, abacá can not be grown in these districts. A short drought will check the growth of the plant, and a long period of dry weather will destroy all growing abacá. In certain parts of Albay, Davao, and some other localities, while there is a so-called wet and dry season, seldom does a week pass without heavy showers. The actual amount of rainfall required by abacá will be modified by the nature of the soil, the degree of atmospheric humidity, and the methods of cultivation. Occasional plowing and harrowing of the soil, beside tending to fill all crevices and thus retarding the evaporation of moisture, also allows the tender and fleshy roots of the abacá to penetrate further into the soil, thus enabling the plant to obtain a larger supply of nourishment and moisture.

The growth of abacá is influenced very directly by the relative humidity of the atmosphere. The degree of atmospheric saturation usually follows the rainfall in its variations, so that in districts where there is a heavy precipitation there are also many days of excessive humidity, the effect of which is almost the same as actual rain. Other conditions being the same, this makes all level locations in the vicinity of large rivers or other bodies of water, or along the base of hills where a constant supply of underground moisture percolates through the soil, best adapted to abacá cultivation. The atmospheric conditions in southern Mindanao are extremely favorable for abacá cultivation.

The abacá plant, with its broad, heavy leaves, may be seriously injured by severe windstorms. The function of the leaf is to assimilate plant food. When it becomes stripped and torn, as is often the case, this power of assimilation is diminished and the growth of the plant is correspondingly retarded. It is always desirable to select locations as protected as possible, and it may be found necessary to plant trees which will serve as wind-breaks.

The following table shows the average rainfall and temperature in certain parts of the Islands:

Province.	Number of years averaged.	Temperature.	Days of rain.	Rainfall.
		°C.		mm.
Albay	6	26.05	218.5	2,750
La Carlota (Negros)	10	26.5	154.3	2,407
Mamburao (Mindoro)	2	----------	147.5	2,895
Iloilo	4	----------	152.6	1,668
Davao	2	----------	187	1,853
Cebu	6	----------	161	1,367

PLATE 5. FIELD OF YOUNG ABACÁ.

PLATE 6. STRIPPING ABACÁ (FIRST PROCESS).

PLATE 7. STRIPPING ABACÁ (SECOND PROCESS).

PLATE 8. DRYING HAND-CLEANED ABACÁ.

SOIL.

Next in importance to favorable climatic conditions is the selection of suitable soil. The appropriateness of any particular soil must depend in a degree on the relative conditions of climate and location. For instance, in a district having a very heavy rainfall and where the land is low and flat a soil of certain consistency would become oversaturated, while the same soil, if the land were sloping and the rainfall less heavy, might be sufficiently well drained. The qualities to be selected are a rich, mellow loam of lasting fertility, cool and moist, but at the same time well drained, containing a large amount of decayed vegetable matter, and preferably of volcanic origin.

Throughout the important abacá districts of southern Luzon we find nearly all of the large plantations situated on the lower slopes of old volcanoes. The soils in these locations are deep and fertile, well drained, and in every way very desirable. As abacá is grown on the same land without replanting, fertilizing, or rotation for a period of at least twelve or fifteen years, the soil must be of lasting fertility in order to stand this long drain on its resources. The demand of the plant for a constant supply of moisture, and its equal dislike for oversaturation, require a condition of medium consistency, a soil that will retain moisture without becoming wet.

There are three kinds of soil in which abacá flourishes and gives remunerative results. These are, in order of superiority, the alluvial plains subject to overflow by rivers or mountain streams, the moist mellow loams formed by the disintegration of volcanic rocks, or by the deposit of volcanic ashes, and the moist and well-drained loams. One or more of these three kinds of soil are found in every district where abacá is successfully cultivated. Dry sandy soil, such as is found along the sea beach, stiff clay loams, and rocky limestone soils should be avoided. An attempt to transform these inferior soils into proper condition either by plowing, irrigating, draining, or fertilizing them, as the case may require, usually entails so much expense and labor that such operations are not practicable. On superior soils, however, these methods of soil treatment often can be used to advantage.

THE PLANTATION.

The prospective planter must consider three things: The selection of a location, the preliminary work of establishment and organization, and the system and method by which the plantation is to be developed.

The location should be, if possible, in some district where abacá is already grown. This will be the surest way of determining that soil and climatic conditions are suitable, and will also guarantee a supply of suckers or "seed" for starting the new plantation. The supply and quality of available labor; the condition of roads and the facilities for

water transportation; the supply of water, wood, and building materials, and the distance from a market, are all matters that should receive consideration.

The site having been selected, the boundary lines should be carefully located, and the plantation mapped out with a view to future development. At some central point, where there is a supply of good water, the necessary buildings may be erected. These will include a residence for the manager, a storage shed for tools and implements, and a shelter for animals. As soon as this preliminary work is finished the clearing and planting should be commenced.

The most difficult problem which the tropical planter has to face, and that which more than any other one thing will determine his ultimate success or failure, is the manner in which he controls and directs his labor. To have available at all times as many workmen as can be used to advantage, and to so handle them as to secure the best results, requires a thorough knowledge of the native character and an infinite amount of tact and patience. When the plantation is first started arrangements should be made for building a native village of sufficient size to accommodate all laborers needed on the plantation, together with their families. By this method the plantation manager will always have under his direct control a fairly reliable supply of labor; and if this system is properly carried out the workmen will be more contented, better satisfied, and in every respect more easily handled than if secured in any other way.

PREPARATION OF THE SOIL.

The clearing of the forest, which is the first process in preparing the land for planting is best accomplished in the following way: The land should first be cleared of all underbrush and weeds, leaving nothing standing but good-sized trees. The underbrush and weeds should be left scattered on the ground until they are perfectly dry, when the felling of all trees, excepting such as are to be left for shade and protection from wind, should commence. After felling the large trees it is advisable to cut off all branches and limbs. This has a double advantage, namely, the material dries more quickly and is also more thoroughly consumed when burned. Where the forest is heavy, two and sometimes three burnings are required. The first burning consists of setting fire to the dry and combustible underbrush and leaves, which in turn set fire to the small branches and twigs. The second and third burnings should be started immediately after the first is finished, and consist in piling up and burning in separate piles all of the limbs and larger branches that remain after the first burning. These successive burnings clear the ground of all waste, destroy a portion of the seeds of weeds, and leave an amount of ash, the potash salts of which furnish a valuable fertilizing material. All clearing and burning should be finished before the close of the dry season.

The preparation of the land for abacá must vary with different local conditions. The most common practice is, after the land has been burned over, to plant at once, without any preliminary plowing or other preparation of the soil. The abacá shoots are set out at regular intervals, camotes (sweet potatoes), mongos, cowpeas, or velvet beans being planted at the same time. These secondary crops grow rapidly, soon cover the ground with a dense growth, and thus to a large extent prevent the growth of weeds. This method may be followed where it is impracticable to secure labor, animals, or implements, or where the land can not be thoroughly cleared. It is not, however, a system to be recommended. Where it is practicable to do so, the land should be plowed and harrowed before planting commences. This system will be more expensive at the outset, but the more rapid growth of the crop and the increased yield on land thus prepared will, in the end, more than pay for the additional first cost.

SEED SELECTION.

Considerable differences in the quality and relative quantity of fiber, as well as in size and extent of growth, exist among the different varieties of abacá. A comparative study of these varieties has shown that the most remunerative among them are Tangoñgon (Lagurjuan), Maguindanao (Samponanon, Laob, Ynosa, Samorong puti), Bangulanon (Alman ?), Libuton (Libutanay), Punucan, and Arupan (Tilitian, Sina-Moro, Puteean Grande, Baounon). Seeds from these varieties, therefore, and only these varieties, should be selected for propagation. The rest should be avoided as carefully as possible, excepting in certain instances where the fiber of a particular variety is desired for special purposes, such as the manufacture of cloth. It is probable that the perfecting of a machine will remove the undesirability of a few of the inferior varieties.

Another fact that emphasizes the importance of seed selection is the adaptibility of certain varieties to certain kinds of soil. Whenever a soil is alluvial deposit underlaid by gravel at a depth of a few feet, the Tangoñgon, Bangulanon, and Punucan varieties are best adapted to it; while, where it is a deep mellow loam, the Maguindanao, Libuton, and Arupan thrive best.

Many grave mistakes have been committed, and considerable losses sustained, by planters at the time they started their plantations through ignorance of the different varieties of abacá. The large plants and excellent appearance of some of the varieties, such as Baguisanon Lawaan (Lackbanon, Ijalas and Tinabonó), Pulajan (Baguisanon itom, Caguisan etc.,), Agutay, and Baguisanon (Banguisan, Lawisid, Macalibre, etc.,), make the inexperienced planter as anxious to secure them for his plantation as the old shrewd planter is to part with them.

PLANTING.

The land, when ready for planting, should be lined out with a cord or bamboo poles and small stakes driven at equal distances apart where the plants are to be set out. Some of the plants will fail to grow, and without these stakes it will be difficult to determine the exact spot for making the new setting. The rows should be from 2.9 to 3.5 meters apart each way, depending on the size of the variety of abacá planted and on the nature of the soil. This will give from 750 to 1,350 plants to the hectare (2.471 acres). The most favorable time for planting is near the beginning of the rainy season.

A new plantation may be started with seed, suckers, or root sections. The one advantage of using seed is that the first cost is less. This method, however, is seldom followed, as it requires from six months to a year longer for the plants to mature from seed than from suckers or root sections. Good seed is difficult to secure, and even when every precaution is taken it often fails to germinate. The seeds of the ripe fruit should be selected, well washed to remove the pulp, and dried. Before planting, soak in water for some five hours and use only the seed which sink to the bottom. Prepare the seed bed carefully in moist, fertile soil and sow in drills 25 to 50 centimeters apart. The plants should be large enough to set out in the field at the end of nine months to a year.

The ordinary method of propagation is by the use of suckers. These suckers grow from the root of the "mother plant" and can be obtained on any large plantation at a cost of from ₱30 to ₱40 per thousand. Care should be taken to secure suckers that are well developed and in good condition. It is always safe to allow for the loss of one-fourth the original number ordered during the period of transportation and after planting.

The use of root sections is the most desirable method of propagation because these roots are cheaper, more easily transported, and more liable to grow than suckers. The easiest way to obtain them is by felling the stalk in such a way as to pull up all, or part, of the root with it. This root section, if small, is set out entire, to start a new plant; but if large, it has been found more desirable to cut it into two or three, sometimes four sections, according to its size. It may be borne in mind, however, that at least two eyes must be found on each section, just the same as is the case in potato planting. If large sections with as many as six or eight eyes on them are planted, it is quite often seen that four to six or more weak and slim stalks grow up from the same root at the same time, making too much demand on the yet young and tender roots for nourishment. On the contrary, when only two stalks grow up at first, they are, as a rule, found to be stout and robust, and grow unchecked and unhindered until leaf and root formation are sufficiently developed

to supply new sprouts. Plants started according to the second method will ultimately have as many stalks as those started according to the first, and will attain a greater size and height.

It is customary to plant some other crop on the same land with abacá. This system is advantageous for several reasons. If the ground is sloping, some herbage plant is necessary to prevent soil washing. Such plants will also prevent, to a considerable extent, the growth of weeds and will yield a product of more or less value. Camotes is the crop most commonly used. This plant grows rapidly, soon covers the ground with a dense mat of vines which chokes out the weeds, and it also furnishes a supply of food for the laborers on the plantation. Corn is very desirable, and it has the additional advantage of furnishing a much needed shade to the young abacá plant. Where soil conditions are favorable, coconuts may be grown on the same land with abacá. Coconuts and abacá make a very profitable combination as the abacá can be harvested until after the coconut trees come into bearing. Other crops sometimes used are mountain rice, cacao, and coffee.

CULTIVATION.

Under the present system where camotes are planted with abacá the only cultivation given is to keep the soil loose immediately around the abacá plants, thus allowing the free growth of suckers, and the frequent clearing of grass and weeds. It will be necessary to go over the plantation every two months, or oftener, during the first year. After the abacá begins to shade the ground the growth of weeds will be less, and after the third year three or four clearings every twelve months will be all that is required.

Clearing can be best and most economically accomplished by hoes instead of bolos. Hoes have proven more effective in checking the rapid growth of weeds and grass than bolos; besides, well-trained boys or men can accomplish almost half as much again with them as with bolos. The weeds should be cut before they have time to flower and seed; thus, in time, they get rarer and rarer, rendering subsequent cleanings of less trouble and expense.

Another very important treatment will be found to add to the general welfare of the abacá plant. This treatment should be applied to the hills after the fourth or fifth year, whether cultivation is by plowing or weeding, and consists of occasionally throwing new soil into the center of the hill, as well as digging up all the decayed roots of the former stalks. The fact that the center of the hill is usually filled with cavities containing the woody substance of the roots of the old stalks and other decayed organic matter, and with scanty soil that is practically exhausted of all nourishment, explains why so very few sprouts ever grow on the inner side of the root stalks. The supply of new soil to the middle of the

hill frequently results in increasing the number of sprouts, in giving a more compact aspect to the hill, and in preventing the breeding of worms, ants, and beetles that usually multiply in the decayed organic matter in the center of the hill.

When the land is thoroughly cleared and plowed before planting, and the abacá is set in straight rows, subsequent cultivation may be done with animals.

SHADE.

The relative advantages and disadvantages of growing abacá under shade is a subject concerning which there is great difference of opinion and one which must be largely decided by the existing local conditions. In any province where there is a pronounced dry season the shade tree may be considered an absolute necessity. Throughout the greater part of the abacá-growing districts it may probably be used to advantage. In certain portions of southern Mindanao, and in other localities where the rainfall is very heavy and is evenly distributed, shade may be dispensed with altogether.

The functions of the properly selected shade tree are as follows: It protects the young abacá plant from the direct and glaring rays of the sun, such protection being very necessary at this stage of growth; it prevents, in a measure, the great evaporation which would otherwise take place from the broad surface of the leaves of the fully developed plant; it brings toward the surface of the ground, within reach of the roots of the abacá, a certain amount of soil moisture; it protects the plant during all stages of growth from severe winds.

The objections to the shade tree are that when it has to be planted it is an additional item of expense; it interferes with the work of cultivation and takes up a considerable amount of land which might otherwise be planted to abacá. If its leaves are large, more or less moisture will be evaporated from them and wasted, and if its roots are shallow the abacá plant will be robbed of a portion of its food. If planted too closely the abacá plant will not receive a sufficient amount of light and heat and its development will be retarded.

If shade trees are to be left standing when new lands are cleared, or if trees are to be planted for this purpose, varieties should be selected which are leguminous and which have tall trunks, narrow leaves, and deep-feeding roots. Such trees will give a light shade, but little moisture will be evaporated from the leaves, and their roots will be beneficial rather than detrimental to the abacá plant. There are many different varieties of trees in the Islands which are suitable for this purpose, among which may be mentioned the dapdap, raran, tanguil, anonang, pili, barobo, and locust. The number of trees required will vary with

local conditions. Ordinarily they should be from 20 to 30 meters apart. In all cases where shade trees are not used, corn or some other quickly grown crop should be planted to protect the young abacá plant during the first months of its growth.

FERTILIZERS.

Commercial fertilizers have seldom, if ever, been used in the growing of abacá. Virgin land, where the soil is deep, fertile, and filled with decayed organic matter is usually selected for this purpose. When the plant is cut and the fiber extracted all of the waste material, which constitutes by far the greater part of the plant, is left on the ground. This practice results in the return to the land each year of a large amount of organic matter, and tends to keep up the fertility of the soil.

The rapid growth of abacá on land that has recently been burned over, together with the fact that chemical analysis shows a large percentage of potash in the composition of both plant and fiber, indicate that the application of ashes or other potash fertilizers would be attended with beneficial results. Until a series of systematic experiments with different fertilizers have been made, their relative value for abacá or the practicability of their application can not be definitely stated.

DRAINAGE AND IRRIGATION.

The most important requisite for successful abacá cultivation being an abundant supply of water, and one of the most undesirable conditions being a wet soil, the value of both irrigation and drainage becomes very apparent.

Besides supplying moisture to the soil, irrigation, especially when the water of small mountain streams which is always rich in organic matter and humus is utilized, enriches the soil by supplying the most desirable manure. If simple methods of irrigation are used where climatic or soil conditions are unfavorable, the total output of hemp can be increased considerably and the area that might profitably be planted to abacá would be largely increased. Even in locations where natural conditions are suitable, irrigation has increased the output to such an extent as to warrant the extra expense.

The introduction of any thorough system of underground tile drains, or the use of any very expensive methods of irrigation, will not ordinarly be practicable where the amount of cheap unoccupied land is as large as it is at the present time in these Islands. On many plantations, however, there are opportunities for utilizing, at little cost, an available water supply, or draining by means of surface ditches, the cost of which would be inconsiderable when compared with the beneficial results.

ENEMIES.

The enemies and accidents to which abacá is subject are but few. The damage done is usually slight and comparatively easy to correct.

Severe winds, which strip and tear the leaves of the plant, will retard its development, and a typhoon may do a great amount of damage. The selection of a protected location and the planting of trees for wind-breaks will, in all ordinary cases, overcome this difficulty.

Extreme drought is another unfavorable climatic condition. A long dry season seldom occurs in the localities where abacá is most largely cultivated, and the effects of dry weather are in a measure overcome by the use of shade trees. Abacá should not be planted in the provinces where the distribution of rainfall is not fairly even, unless some means of irrigation are available.

Wild pigs, deer, and carabaos occasionally do some damage, and it is usually necessary to fence a plantation. Locusts and ants are not to be feared. The larvæ of two insects, known locally as "tamilos" and "amasog," sometimes attack abacá. The first of these is about 4 centimeters long and has a body divided into twelve segments, a soft, white skin, a head of a dark red color, and strong mandibles. The latter is about 1½ centimeters long with a body of uniform dimensions and white in color. When a plant is affected, a relatively large hole is found in the trunk and the leaves turn yellow. Such a plant should be immediately removed and burned. Fortunately but few plants suffer from these insects and the total injury which they do is insignificant.

HARVESTING.

The first stalks will be ready for cutting at from twenty months to three years after planting. The time required for development varies considerably with different varieties and in different localities. After the first harvest it is customary to cut over a plantation every six to eight months.

The abacá plant when mature consists of a group or a cluster of from twelve to thirty or more stalks, all growing from the one root. These stalks are in all stages of development, but usually two or three will mature and can be cut at the same time. The stalk is ready for cutting at the time of the appearance of the flower or shortly before. When the plant is in flower the large violet-colored flower bracts fall to the ground, making it an easy matter when passing through the field to select the plants which are ready for cutting.

The stalk is cut with a bolo or knife having a sharp blade. This cutting should be made 5 to 7 centimeters from the crown of the root and on a slant. If a perfectly horizontal cut is made, water will collect on the stump, causing it to rot and thus injuring the root and remaining shoots.

PLATE 9. DRYING MACHINE-CLEANED ABACÁ (SHOWING TWO GRADES OF FIBER).

PLATE 10. FIELD OF OLD ABACÁ.

PLATE 11. ABACÁ FRUIT AND SEED.

Owing to the fact that the stalks of a hill of abacá, especially young hills, are crowded together and that they are, to a certain extent, tied to each other by their old dry leaves, great care should be excercised in felling them. If laborers are left to themselves, they will be found to cut the stalks at the bottom and leave them to fall of themselves, quite often bringing down with them other immature stalks. The loss, however, is not only the immature stalks, but the roots with all that would have grown from them as well. To avert this danger special men should be trained to cut down stalks and made responsible for any damage of this kind. To these men should be given a long pole with a very sharp knife attached to the top with which to cut off the top of the stalk, as well as all leaves tying it to the other stalks. The stalk, being left separate, could then be cut in the manner indicated above.

Another grave mistake is often made in harvesting abacá. Owing to some pecuniary difficulties or to ignorance, some planters overcut the hills, leaving none but young shoots. This method is ruinous to the abacá plant. It opens the hill too much to the sun, increases the growth of weeds, shortens the life of the hill, and reduces the total output of fiber.

EXTRACTION OF FIBER.

The extraction of fiber should commence within forty-eight hours after the cutting of the stalk. If left a longer time than this, the fiber is liable to become discolored and weakened, and the stalk will lose some of its outer sheaths from drying or decaying. As the abacá trunk is heavy and the fiber-extracting apparatus is light and easily transported, it is customary to move the latter from place to place and extract the fiber near the spot where the stalk is cut.

The trunk or stalk of abacá ranges from 2 to 7 meters in length and from 15 to 45 centimeters in diameter. This trunk consists of a small, central fleshy core from 15 to 25 centimeters in diameter at the base to about 3 centimeters at the top, around which are a number of thick overlapping sheaths, each sheath being the stem or petiole of a leaf. The fiber is obtained from the outer portion of these sheaths. The process of fiber extraction consists of two distinct operations: First, the removal of the ribbon-like strips of fibrous material from the leaf sheath, and second, the separation of the individual fibers by pulling these ribbons under a knife.

The laborer, sitting on the ground with a stalk of abacá across his knees, inserts under the bark of one of the leaf stems a small, sharp piece of bone called a "locnit" and pulls off a fibrous strip 5 to 8 centimeters wide and as long as the stalk. One sheath will yield two to four such strips. When these fiber strips have been taken off, the remaining fleshy material is removed and each consecutive sheath is thus worked, down to the central core of the stalk.

These strips should be graded according to their color and each grade stripped separately. This grading of strips helps a great deal when subsequent grading of the fiber is required. It will be found that five or six grades of strips can be made ranging in color from a dark red to white. But two grades, however, are ordinarily made of these strips, the fiber of which is separately stripped and handled.

When a quantity of these fiber strips has been collected, they are carried to some central point where a shed has been erected and an apparatus set up for stripping the fiber. The shed consists of a frame of bamboo poles covered with abacá leaves. The stripping apparatus, known as the "panguijan" or "jagutan" is simple both in construction and operation. It consists of a log set in a horizontal position 0.5 meter to 1.5 meters from the ground. On the top of this is fastened a block of smooth, hard wood. Over this block is placed a bolo having a blade about 30 centimeters long and a handle 40 centimeters long. A rattan is attached to the end of the knife handle and connected with the bamboo spring above. Another rattan passes from the handle to a foot treadle. The bamboo spring holds the knife down on the block, its pressure being easily regulated by lengthening or shortening the rattan. By means of the foot treadle the operator raises the knife when he desires to insert or remove a strip of fiber.

In the process of stripping, the operator holds in his right hand one or more of the fiber ribbons and also a short, round piece of wood. These strips are inserted under the knife and are drawn through with a quick, steady pull. The ribbon is then removed and reversed, the clean end being wound three or four times around the stick. This process of drawing under the knife removes all of the pulp or fleshy material, leaving in the hand of the operator a small bunch of clean, wet fiber. As the fiber is stripped it is usually assorted into two classes. The work of fiber extraction while apparently simple, is very exhausting, even for the experienced operator, and many laborers are ruptured by the excessive strain of pulling the fiber strips under the knife. It is a fair day's work to strip 9 kilos and the fiber stripper will usually work only four or five days a week.

Practically all of the fiber produced in the Islands is extracted with this simple apparatus. The strength and color of the fiber—two most important qualities—are determined largely by the manner in which it is cleaned. Two factors in the process affect the quality of the product, the condition of the knife blade and the degree of pressure with which the knife is held upon the base block. With a serrated knife loosely fastened the fibers are only partially separated and only a portion of the pulp is removed; the work is easy, the yield large, but the fiber is inferior in quality. With a knife having a smooth-edged blade and held firmly on the base block, the work of extraction is much more difficult and the waste is greater, but a very superior fiber is obtained.

It has been determined by experiment that the same plant will produce either a very superior or a very inferior grade of fiber, depending on the kind of stripping knife used. As a result of using serrated knives, the markets have been flooded with enormous quantities of inferior fiber, and cordage manufacturers frequently make complaint about the quality of manila hemp. The whole future of the industry depending, as it must, on the position which abacá continues to hold in the world's markets, it is manifestly to the interest of every producer to discourage the use of the serrated knife.

The present method of scattering strippers all over the field has a great many disadvantages. First, the overseer can not watch the laborers as closely and as often as necessary; second, the laborers are apt to cut the large stalks only, or the stalks of certain good varieties, leaving out the small stalks and omitting the hills of inferior varieties; third, the strippers have no interest in turning out a good quality of fiber, and often, if not watched, reduce the tension of the knife by loosening the rattan or rope, or by reducing the weight (where a weight is used to regulate the tension of the knife) thus making it much easier to pull the strips; and fourth, they work at their leisure, starting and finishing work at their convenience.

These disadvantages can be remedied by having a long shed built at a spot as near the center of the plantation as possible, under which all strippers should be made to set up their knives. A gang of men specially trained in separating the strips and felling the stalks should be employed under a competent overseer; while a few boys with carts and carabaos or cattle can haul the strips from the field to the shed and turn them over to the man in charge there, who, in turn, distributes them to the men under him.

It has been amply demonstrated that by this method six advantages will be gained: First, the field is harvested in one uniform way throughout; second, the hills are better handled and every mature stalk in them, whether large or small, is harvested; third, the total output of fiber per hectare is increased; fourth, more work is gotten out of the laborers; fifth, a better quality of fiber is turned out, as the strippers can no longer meddle with the knives, and also the fiber is better handled and dried; and sixth, sickness among laborers is reduced as they are not exposed to changes of climate, such as heat, wind, and dampness, as they are when working in the field.

FIBER-EXTRACTING MACHINERY.

Numerous attempts have been made to perfect a machine for extracting abacá fiber. A number of these machines have been in a measure successful, but some defect has always prevented their coming into general use.

During the past five years this subject has received a great deal of

attention and as a result three different machines are now in operation in the abacá provinces. Other machines are being experimented with, so there is a good prospect that machine-cleaned abacá will soon be produced on a commercial scale. The introduction and general use of a satisfactory fiber-cleaning machine will do more than any other one thing to promote the development of the abacá industry.

AFTER-TREATMENT OF FIBER.

Abacá after being stripped is hung on bamboo poles to dry. This drying takes from three or four hours to two days. When thoroughly dry the fiber is collected, tied up in hanks or bundles, and in this condition is shipped by ponies, carabaos, or cargadores to the nearest market. It is there sold to a Chinese middleman or to the representative of some one of the large exporting firms in Manila. When the fiber reaches the warehouse of the exporter it is carefully sorted into different commercial grades, and is then baled, each bale weighing 2 piculs (275 pounds).

In all districts where abacá is most successfully cultivated the rainfall is abundant and the distribution fairly even throughout the year. This fact, while favorable for the growth of abacá is also in part responsible for the immense quantities of inferior fiber that flood the market, as during rainy weather bundles of wet fiber are packed indoors. To keep the fiber spread out on bamboo poles out of doors is better than keeping it inside, but the successive changes of sun and rain prevent its drying with the required color and luster. The following has proven to be the best method for drying abacá, and is becoming more universally adopted by planters in districts which produce the best fiber. A long and open shed is erected. From the two sides rows of galvanized iron wire are stretched to some distance and fastened by poles. As soon as the fiber is stripped it is brought to the drying shed and spread on one of the rows until it is dry. If the weather looks threatening and rain imminent, a boy in a few minutes can slide the fiber along the rows of wire into the shed, which, if the fiber is not yet dry, should be left open until the rain is over, and the fiber then slid out again. It has been further claimed that drying under shade in a place exposed to the full play of the wind is preferable to drying by sun. Experiments in drying samples of fiber under shade have been made and the results proved highly satisfactory.

When the fiber is used locally for the manufacture of cloth it undergoes a much more elaborate process of treatment. The sheaths in the center of the stalk are selected and the fiber is often drawn several times under the stripping knife. This gives a product that is fine, soft, and white. If to be used for the finer textures, it is then placed in a wooden bowl and beaten with a mallet until the required fineness and elasticity are obtained. This process gives a fiber that is almost like silk, and some of the cloth made from the best quality of abacá rivals in delicacy and beauty the celebrated fabrics of piña and jusi.

DESCRIPTION OF FIBER.

Abacá fiber of good quality is from 2.5 to 5 meters long, of glossy white color, very light and strong, and of clean, even texture. As a cordage material it has no superior, its chief value, particularly for ships' ropes, being its relative lightness and strength. The strength of abacá compared with that of English hemp is indicated by the following figures: A manila rope 7.5 centimeters in circumference and 3.35 meters long stood a strain of 2,122.27 kilos before giving way. The English rope of the same size broke with 1,766 kilos. In a second test with a rope 3.56 centimeters in circumference the manila rope broke with 677.27 kilos, and the English with 538.18 kilos.

YIELD.

The yield of fiber varies greatly, depending upon soil and climatic conditions, the use of modern methods of cultivation, the selection of superior varieties, irrigation, and careful management. From 375 to 2,500 kilos (6 to 40 piculs) or even more, can be obtained per hectare, but an average of 1,000 to 1,250 kilos (16 to 20 piculs) is considered a good yield; while the average yield throughout the Islands does not exceed 375 kilos (6 piculs) per hectare. The yield of fiber from a single stalk varies with the size and kind of stalk. From 0.15 kilo to 2.270 kilos of fiber can be obtained from one stalk; but an average of 340 to 455 grams is considered highly satisfactory. Stalks weighing as much as 163 kilos and containing 2.5 kilos of dry fiber are sometimes found.

METHOD OF RENEWING OLD PLANTATIONS.

The life of an abacá hill varies from twelve to twenty years or more, depending upon the adaptability and fertility of the soil, and on the extent of care and cultivation. Heavy soils, lack of cultivation, carelessness in felling the stalks, overcropping, and the frequent digging up of roots tend to shorten the life of the abacá hill.

In the provinces where the cultivation of abacá has recently been started this subject has not, as yet, been given any consideration as the plantations are comparatively young. In the Provinces of Albay, Leyte, Sorsogon, and others, where abacá has been cultivated for years, the prevalent method of renewing the plantations consists in digging up one or two immature stalks or shoots from an old hill and planting them in the intermediate spaces. This system of renewing plantations is wholly undesirable and the hills thus produced are, for obvious reasons, neither so healthy nor so productive as the original ones.

Every year a part of the old plantations should be plowed to a depth of 14 to 19 centimeters and a crop of corn or rice raised on it. After the crop is harvested all that is left of the corn or rice should be plowed under. After these operations abacá stools or root sections could be set

in as in the first planting. Cleaning with bolos should be done away with, and the successive operations of cultivation and interplanting of leguminous plants, such as cowpeas, mongo, velvet beans, etc., should be resorted to, in order to kill the weeds, keep the soil in good condition, and restore it to its fertility. Thus in the course of a few years a new plantation with healthy, vigorous hills will stand on the site of the older one.

Many old planters hold that the above method entails too much expense and trouble, but they have only to try it to find out that the ultimate results more than justify the expense and trouble.

VALUE.

The relative value of abacá and other products exported from the Philippine Islands during the fiscal years 1908 and 1909 was as follows:

Product.	1908		1909	
	Values.	Proportion of total value.	Values.	Proportion of total value.
		Per cent.		*Per cent.*
Abaca	₱34,623,616	52.7	₱31,667,154	51.0
Sugar, raw	11,329,332	17.2	8,746,676	14.1
Copra	10,922,360	16.6	13,315,480	21.5
Tobacco, cigars, and cigarettes	5,429,092	8.2	5,584,506	9.0
All other exportations	3,354,232	5.3	2,775,100	4.4
Total	65,659,632	100.0	62,088,916	100.0

"In quantity, exportations of hemp fiber exceeded those of any previous year, having aggregated 149,991 metric tons. Of this amount 79,210 tons represent the largest exportation to the United States in the history of the trade. Despite an increase of 34,000 tons, or nearly 30 per cent, in exportation, the average price obtained was 24 per cent lower than that of 1908, resulting in a decrease from $17,311,808, the value of the 1908 output to $15,833,577, representing the total hemp exportations of 1909." [1]

The Manila market report for December 22, 1909, gives the following hemp quotations:

Albay, current	₱11.00
Leyte, current	14.4
Daet, current	11.2
25 per cent over, current	11.2
Superior seconds	10
Good, seconds	9.6
Good, reds	8.6

[1] Annual Report of the Acting Insular Collector of Customs for the Fiscal Year ending June 30, 1909.

USES.

Abacá is, primarily, a cordage fiber. Its most important use is in the manufacture of various classes of cordage, ropes, and cables. Enormous quantities of the fiber are used in the United States for making binder twine. Because of its lightness, strength, and durability manila hemp is considered superior to any other fiber for ship's ropes and cables. From the old and disintegrated ropes is made the well-known and valuable manila paper.

In the Philippine Islands a considerable quantity of abacá cordage is manufactured, and the raw fiber is used without being twisted for all purposes where a tying material is required. Its most important local use, however, is for the manufacture of cloth. The native dress of both sexes in nearly all parts of the Archipelago is made from "sinamay," or abacá cloth. Looms are to be found in nearly every town in the Islands. The abacá fiber is frequently woven with either cotton or silk, in an almost innumerable variety of patterns. The fabrics made are of every degree of fineness, from delicate silk-like tissues to the coarse material used for fishing nets. With the introduction of fiber-extracting and textile machinery there should be a largely increased demand for abacá as a textile fiber.

UTILIZATION OF ABACÁ WASTE.

In the extraction of abacá by the methods now in use it is estimated that from 25 to 30 per cent of the fiber is wasted. At each cleaning shed we find large piles of waste which is filled with fibrous material. In 1887 samples of this waste were delivered to Messrs. Gonzales' Sons, paper manufacturers of Barcelona, Spain. Their report upon this material was as follows:

> Observations made in the course of manufacture permit us to state that abacá waste as a raw material for the manufacture of paper is not only utilizable, but surpasses esparto and hemp, and, in its treatment for conversion into paper, excels rags and other material known in the industry.

Investigations to determine the value of abacá waste as a paper-making material and the practicability of exporting this product have been made by the Bureau of Agriculture and the Bureau of Science in Manila. The results of these investigations, which have already been published, show that this waste is a valuable paper-making material. The practicability of exporting the waste, however, is largely a question of supply and demand—demand for material of this kind and supply of old manila rope waste, which is a competing product. Inasmuch as the limited supply of rope waste is insufficient to meet the rapidly increasing demand, it is probable that abacá waste, either in its raw state or as a partly

manufactured product, will be exported in the very near future. At the present time there is a market in Manila for any amount of waste that can be supplied.

The work of preparing this waste for export is both simple and inexpensive. Boys and girls between the ages of 9 and 13 could be employed for this work, thus making it unnecessary to use men who could be more profitably employed in cultivating and stripping. If the fiber strips are properly separated, the knife well adjusted, and the stripper properly trained, the waste will come out from under the knife in almost exactly the condition required, needing no handling further than squeezing out the sap and drying in the sun.

Abacá waste can be sold on the plantations for ₱2 to ₱2.50 a picul, depending on the extent of cleaning and drying. The color of the waste has nothing to do with the quality or selling price. If strippers are centralized and a number of boys employed with them to pick the waste and clean and dry it as soon as it falls from the knives, it will be found that a boy who gets from 20 to 30 centavos per day can clean and dry from 25 to 30 pounds a day. As a picul of this clean waste can be prepared at an expense of ₱1.40 to ₱1.50, a profit to the planter of ₱0.60 to ₱1 on each picul will be left.

It should be stated that sisal waste or fiber can not compete with abacá in this industry. Sisal fiber, besides being weak, does not boil down to paper pulp, and its presence in old manila rope is detrimental.

With only a limited competition and with excellent prospects for an increasing demand and higher prices, the question of utilizing abacá waste for paper-bag manufacture should receive consideration and attention from every abacá planter in the Islands.

ESTIMATED COST AND REVENUES OF AN ABACÁ PLANTATION.

The following is an estimate of the cost of establishing an abacá plantation. The size of the plantation selected is 100 hectares. Planting 25 hectares a year, it would require four years to put this amount of land under cultivation. With respect to the cost of clearing and cultivating land, and also the yield, there will be considerable variation, depending on the existing conditions where the plantation is located. This general estimate is prepared from figures obtained from personal experience on an abacá plantation. It should be understood that a large part of the labor employed can be paid for in rice, cloth, and other commodities, which will give a profit that should considerably more than pay for all incidental expenses that may occur. All accounts in this statement are in Philippine currency, and rate of interest is not included in the estimate. The prices of fiber are the current prices paid in Manila for good hemp during December, 1909.

First year.

Expendable:	
Cost of 100 hectares, at ₱10 per hectare	₱1,000
Clearing 25 hectares, at ₱40 per hectare	1,000
Purchase of 25,000 abacá roots, at ₱40 per 1,000	1,000
Lining, holing, and planting, at ₱5 per hectare	125
Cultivation of 25 hectares (first year), at ₱10 per hectare	250
Fencing and roads	800
3 carabaos or cattle, at ₱80, and 2 horses, at ₱50 each	340
Buildings (manager's residence, ₱800; men's quarters, ₱200)	1,000
Manager's salary, ₱2,400; subsistence, ₱720	3,120
One native overseer, at ₱30 per month	360
Tools and implements	200
Half cost of survey (other half chargeable to other plantings)	250
Total	9,445

Second year.

Expendable:	
Clearing 25 hectares, at ₱40 per hectare	₱1,000
Purchase of 25,000 abacá roots, at ₱40 per 1,000	1,000
Lining, holing, and planting, at ₱5 per hectare	125
Cultivation of 50 hectares (first and second years), at ₱10 per hectare	500
Fencing and roads	800
Salary and subsistence of manager	3,120
One native overseer	360
Depreciation on tools, animals, and buildings	340
Total	7,245

Third year.

Expendable:	
Clearing 25 hectares, at ₱40 per hectare	₱1,000
Purchase of 25,000 abacá roots, at ₱40 per 1,000	1,000
Lining, holing, and planting, etc., at ₱5 per hectare	125
Cultivation of first year's planting, at ₱15 per hectare	375
Cultivation of second and third year's planting, at ₱10 per hectare	500
Manager's salary and subsistence	3,120
Two native overseers	600
Additional quarters of men	100
Depreciation	340
Transportation of 250 piculs of hemp to shipping place	25
Total	7,185
Income:	
From 25 hectares, 250 piculs, 50 per cent of full crop (full crop reckoned at 20 piculs per hectare), one-half paid for stripping, at ₱14 per picul	1,750
Debit balance	5,435

Fourth year.

Expendable:	
Clearing 25 hectares	₱1,000
Purchase of 25,000 abacá roots	1,000
Lining, holing, planting, etc	125
Cultivation, first and second year's plantings	750
Cultivation, third and fourth year's plantings	500
Manager's salary and subsistence	3,120
Overseers' salaries	600
Transportation and handling of 750 piculs prior to shipping	75
Depreciation	360
Extra tools, two carts, etc	200
Total	7,730
Income:	
25 hectares, full crop, 500 piculs, and 25 hectares, half crop, 250 piculs; total, 750 piculs, at ₱7 net	5,250
Debit balance	2,480

Fifth year.

Expendable:	
Cultivation of 50 hectares, at ₱20 per hectare	₱1,000
Cultivation of 50 hectares, at ₱10 per hectare	500
Manager's salary and subsistence	3,120
Overseers' salaries	720
Depreciation	400
Repairs, improvements, and additions	200
Handling 1,250 piculs of hemp prior to shipping	125
Total	6,065
Income:	
From 50 hectares, full crop, 1,000 piculs, and from 25 hectares, half crop, 250 piculs; total, 1,250 piculs, at ₱7 per picul	8,750
Credit balance	2,685

Sixth year.

Expendable:	
Cultivation of 75 hectares, at ₱20 per hectare	₱1,500
Cultivation of 25 hectares, at ₱10 per hectare	250
Manager's salary and subsistence	3,120
Overseers' salaries	720
Handling 1,750 piculs of hemp prior to shipping	175
Depreciation	400
Total	6,165
Income:	
From 75 hectares, full crop, 1,500 piculs; from 25 hectares, half crop, 250 piculs; total, 1,750 piculs, at ₱7	12,250
Credit balance	6,085

Seventh year.

Expendable:	
Cultivation of 100 hectares, at ₱20 per hectare	₱2,000
Manager's salary and subsistence	3,120
Overseers' salaries	800
Handling of 2,000 piculs prior to shipping	200
Improvements, additions, etc	200
Depreciation	400
Total	6,720
Income:	
From 100 hectares, full crop, 2,000 piculs, at ₱7 per picul	14,000
Credit balance	7,280

CONCLUSION.

The future development of the abacá industry will depend chiefly on the position which this fiber continues to hold in the industrial world. The superior qualities and intrinsic value of abacá are thoroughly well known in all parts of the world. Its only dangerous competitor at the present time is sisal, which is an inferior fiber.

The opportunities for the extension of the industry are almost unlimited. Improved methods of cultivation will largely increase the production on land already planted, while enormous areas now covered with forest are in every way suitable for abacá. The introduction of fiber-extracting machinery should result not only in a large increase in the quantity of fiber produced, but also in a decided improvement in quality.

The abacá plantation of the past has been, in general, conducted in anything but a businesslike manner. Antiquated methods, careless management, and waste have been the rule rather than the exception. The planter of the future who, with carefully selected land, good management, and the intelligent use of modern methods and machinery, aims at the production of a superior fiber at a minimum cost, has every prospect of ultimate success. With but little danger from insects or plant diseases, or unfavorable climatic conditions, abacá is eminently a safe crop. Even with the present prices it is one of the most profitable branches of agriculture for the Philippine planter.

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